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Zygentoma of Switzerland: Faunistic contribution with first records of *Ctenolepisma longicaudatum* and new occurrences of *Atelura formicaria*

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Abstract

Zygentoma, encompassing silverfish and allies, are an ancient lineage of wingless insects, often associated with human environments in Central Europe. Knowledge in Switzerland on the distribution and ecology of both native and non-native species is very limited. This study summarizes the historic and current knowledge on the distribution and ecology of Zygentoma in Switzerland using a literature review, specimens' collection, and citizen science observations submitted to iNaturalist.org and GBIF.org. We document three native species: *Atelura formicaria* Heyden, 1855, *Lepisma saccharinum* Linnaeus, 1758 and *Ctenolepisma lineatum* Fabricius, 1775 and three non-native, synanthropic taxa: *Ctenolepisma longicaudatum* Escherich, 1905 and *Ctenolepisma phantasma* Molero-Baltanás, Raphel, Mitchell & Jose, 2025 as well as the greenhouse-associated taxa *Nicoletia phytophila* Gervais, 1844. Synanthropic species seem to benefit from modern building designs and are now widespread. Climate change may further promote expansions into outdoor environments and enable new species to colonize Switzerland. The combination of cryptic, nocturnal behaviour, identification challenges, and a lack of systematic monitoring has resulted in significant knowledge gaps. Ongoing surveys, specimen collections, and the continued use of citizen science platforms are essential for tracking future changes in the distribution and community composition of Zygentoma in Switzerland.

Key Words

Dark taxa, Distribution, Fischchen, Identification, New records, Pest species

Introduction

Zygentoma, commonly referred to as silverfish and allies, are an evolutionarily ancient lineage of insects (Grimaldi 2010). Like Archaeognatha (also known as Microcoryphia), Zygentoma are wingless; however, they lack the strong jumping ability of Archaeognatha, commonly referred to as jumping bristletails. Morphologically, the two groups are also easily distinguished: while Zygentoma are dorsoventrally flattened, Archaeognatha have a distinctly arched, humpbacked profile. Jumping bristletails possess large compound eyes meeting each other at the dorsal midline, whereas Zygentoma possess only relatively small and simple compound eyes with only few ommatidia. Species of Atelurinae and Nicoletiinae are completely eyeless. Among insects, Zygentoma are notable for their unusually long lifespan and can live for several years (Lindsay 1940; Aak et al. 2021; Kulma et al. 2021). For example, *Ctenolepisma longicaudatum* (Escherich, 1905) requires up to 14 moults and sometimes several years to reach sexual maturity (Lindsay 1940; Aak et al. 2019).

In Central Europe, most species of Zygentoma occur in close association with human environments. Some species

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are capable of feeding on materials such as textiles and paper, although significant damage is usually limited to places like archives and museums (Querner 2015; Aak et al. 2021). They also feed on other organic matter, such as dust, and mould, thus even assessed to be beneficial in some contexts (Zimmermann 2016). Zygentoma are suspected to trigger allergic reactions (Witteman et al. 1995), although a direct link has never been established (Boquete et al. 2008; Aak et al. 2019), and said to spread fungi through museums and archives (Querner and Sterflinger 2021). While rarely noticed due to their nocturnal behaviour, their presence in buildings can cause discomfort or unease (Aak et al. 2021).

In Switzerland, *Lepisma saccharinum* Linnaeus, 1758 has been recorded since at least the 18th century (Füssli 1775), and *Ctenolepisma lineatum* Fabricius, 1775, was described from Switzerland. *Atelura formicaria* Heyden, 1855 was recorded later in Switzerland (Wygodzinsky 1941). *Atelura formicaria* is obligatorily associated with ants and usually not found in buildings, while *L. saccharinum* and *C. lineatum* are found both in- and outdoors. A more recent summary (Burckhardt 2000) reported three confirmed and one suspected species in Switzerland. In a report on insect diversity by the Swiss Academy of Sciences (Widmer et al. 2021), these three species were considered confirmed, and an additional zero to three species were estimated to occur in Switzerland but lacking direct records (Widmer et al. 2021).

Since then, the presence of the greenhouse-associated *Nicoletia phytophila* (Gervais, 1844) has been documented in Switzerland (Gilgado et al. 2021). There are also observations and evidence suggesting the presence of *C. longicaudatum* and a newly recognized species *Ctenolepisma phantasma* Molero-Baltanás, Raphel, Mitchell & Jose, 2025 recently distinguished from *Ctenolepisma calvum* (Ritter, 1910). Since mentioned from surrounding countries *Thermobia domestica* (Packard, 1837) is expected to occur in Switzerland.

To update the Swiss species list and distributional knowledge for all Zygentoma, we combined targeted prospections and specimen collection with a compilation of occurrence data from online biodiversity databases. Specifically, we reviewed and validated citizen-science observations on iNaturalist and complemented these with records accessed with GBIF. All species are presented in this report (Fig. 1), with a discussion of their distribution and colonization history in Switzerland.

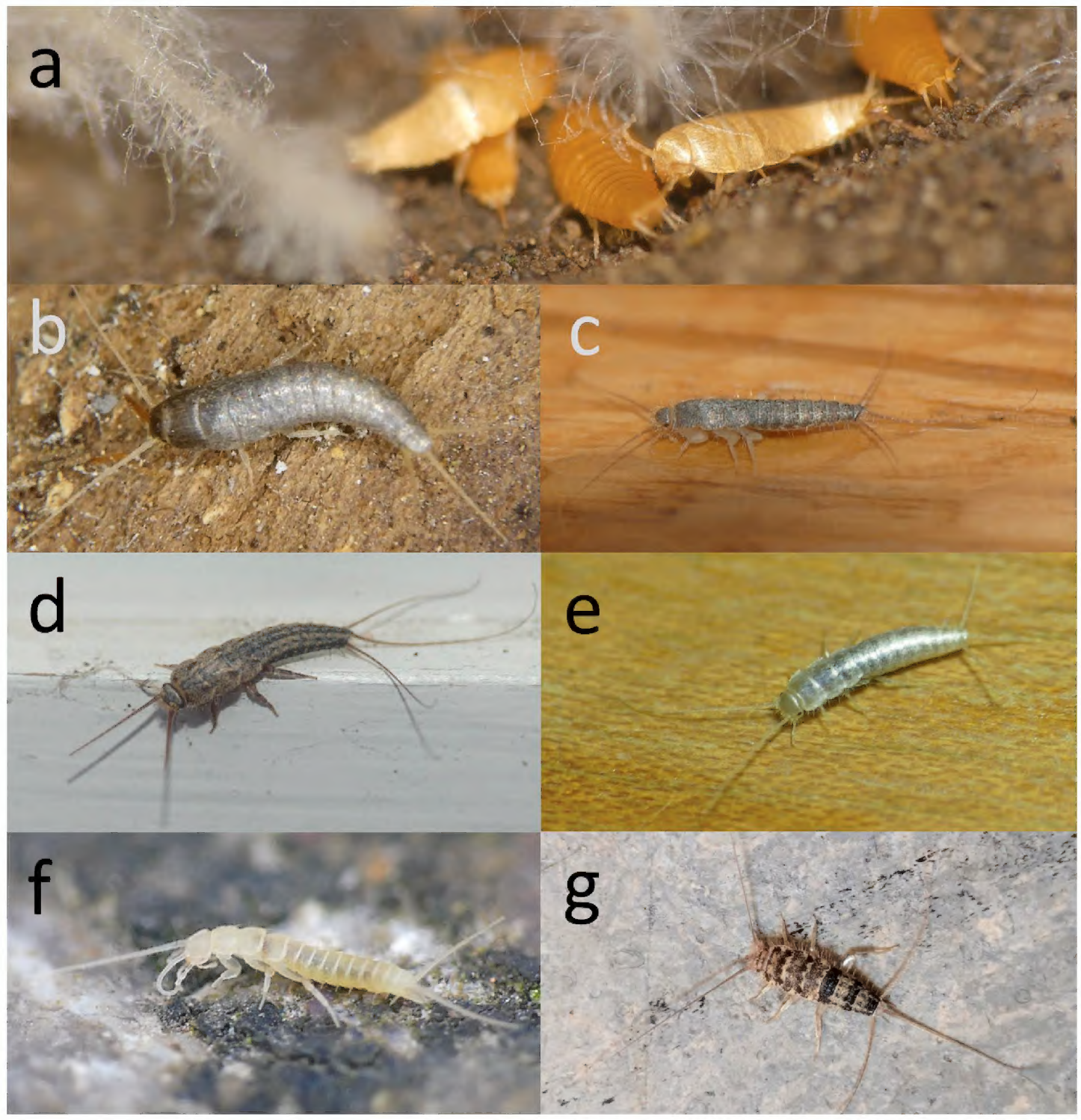

Figure 1. Zygentoma of Switzerland: **a.** *A. formicaria*; **b.** *L. saccharinum*; **c.** *C. longicaudatum*; **d.** *C. lineatum*; **e.** *C. phantasma*; **f.** *N. phytophila*; **g.** *T. domestica*. A presence of *T. domestica* could not be confirmed. Sources: Valentin Moser (**a, c, d, e, f**); Erwin Gilgen (**b**), Jefferson Ashby (**g**).

Material and methods

In recent years, we searched, collected, or at least photographed Zygentoma specimens. Most observations were incidental nighttime encounters. In most buildings where the authors stayed for several nights, Zygentoma could be observed.

Special efforts were made to search for rare or localized species, i.e. *Nicoletia phytophila*, *Thermobia domestica* and *Atelura formicaria*. For *T. domestica*, we contacted a few bakeries, and the Swiss Pest Control Association, who distributed a call for *T. domestica* to their members. For *A. formicaria* we tried to confirm the existing location and find further locations, as well as reaching out to other specialist, in particular ant and ant cricket experts, expected to encounter this species more likely.

We also checked and exported data from GBIF.org for all. On GBIF, many observations came from iNaturalist.org. iNaturalist is a picture-based citizen science platform where anyone can report sightings. Only observations classified as "research grade" on iNaturalist are transferred to GBIF and therefore included in this study, meaning the identification had been made by at least two independent users (often including the authors) and supported by a two-third majority. Prior to the GBIF exports on the 29.01.2026, we reviewed all Swiss observations on iNaturalist to ensure minimal quality of the exports. However, picture-based records are less reliable than specimens, as identification of pictures is often difficult (Kulma et al. 2021; Molero-Baltanás et al. 2024).

Identification keys used to verify collected and photographed species include Molero-Baltanás et al. (2024), Aak et al. (2019), and Querner (2022). It should be noted that Molero-Baltanás et al. (2024) highlights a correction to previous keys: in the species formerly referred to as *C. calvum*, dorsal combs of bristles do occur, but are indeed extremely small and easily overlooked. This work follows the taxonomy proposed by Molero-Baltanás et al. (2024) with updates concerning with updates concerning European representatives of *C. calvum*, which were assigned to the newly described species *C. phantasma* (Raphel et al. 2025).

ChatGPT and deepl.com were used in translating an earlier version from German to English and to polish the writing.

Results

Inferences on the distribution of species in Switzerland are deduced based on historical records and mentions in literature, complemented in presented distribution maps by own recent observations and by records exported from GBIF. Results are presented with native taxa first, followed by non-native taxa; within each group, species are ordered alphabetically.

Historic and previously published records of Zygentoma species in Switzerland

Historic records of *L. saccharinum*, *C. lineatum* and *C. phantasma* were already collected by Molero-Baltanás et al. (2024). In this dataset, some records from the region of Basel by Wygodzinsky (1941) are summarized as Basel or Basilea, but other than that we could not find further records in the literature. However, for completeness, we list all records below. For the map (Fig. 2) we include the historic locations where we could find at least a canton as a locality (Wygodzinsky 1941; Gilgado et al. 2021), but had to exclude more vague locations (Fabricius 1775; Füssli 1775; Gervais 1844; Zimmermann 2016; Querner et al. 2022).

Atelura formicaria

The species was last reported over 80 years ago from the Basel region (Handschin 1929; Wygodzinsky 1941; Meineke 2016).

Lepisma saccharinum

The first records come from houses reported by as early as the 17th century (Füssli 1775). Outdoor populations "living on rock" in dry-warm microhabitats are reported from Lützeltal (BL), Trübbach (SG), and Aigle (VS), along with records from houses in Basel (BS), Arlesheim (BL), Gais (AR), Zug (ZG), and Flims (GR) (Wygodzinsky 1941).

Ctenolepisma lineatum

Older records exist from buildings in Basel (BS), Geneva (GE), and from outside a house in Roveredo (GR) (Wygodzinsky 1941; Janetschek 1949), as well from areas bordering Switzerland (Kinzelbach and Kinzelbach 1968). More recent observations of free-living individuals come from northeastern Switzerland (Zimmermann 2016).

Ctenolepisma longicaudatum

For Switzerland, 2018 is indicated as the first year with observations in the literature (Kulma et al. 2021). This is based on iNaturalist photos, although images on this platform from 2017 exist, and Zimmermann (2016) mentions observations even earlier. These observations are based on data from the Pest Management Unit of the City of Zurich, with the first observations from 2008 onward, still some years later than neighboring countries (Kulma et al. 2021).

Ctenolepisma phantasma

In Switzerland, the first known record dates to 2017, and the species was detected regularly between 2019 and 2021 in at least three museums during pest monitoring

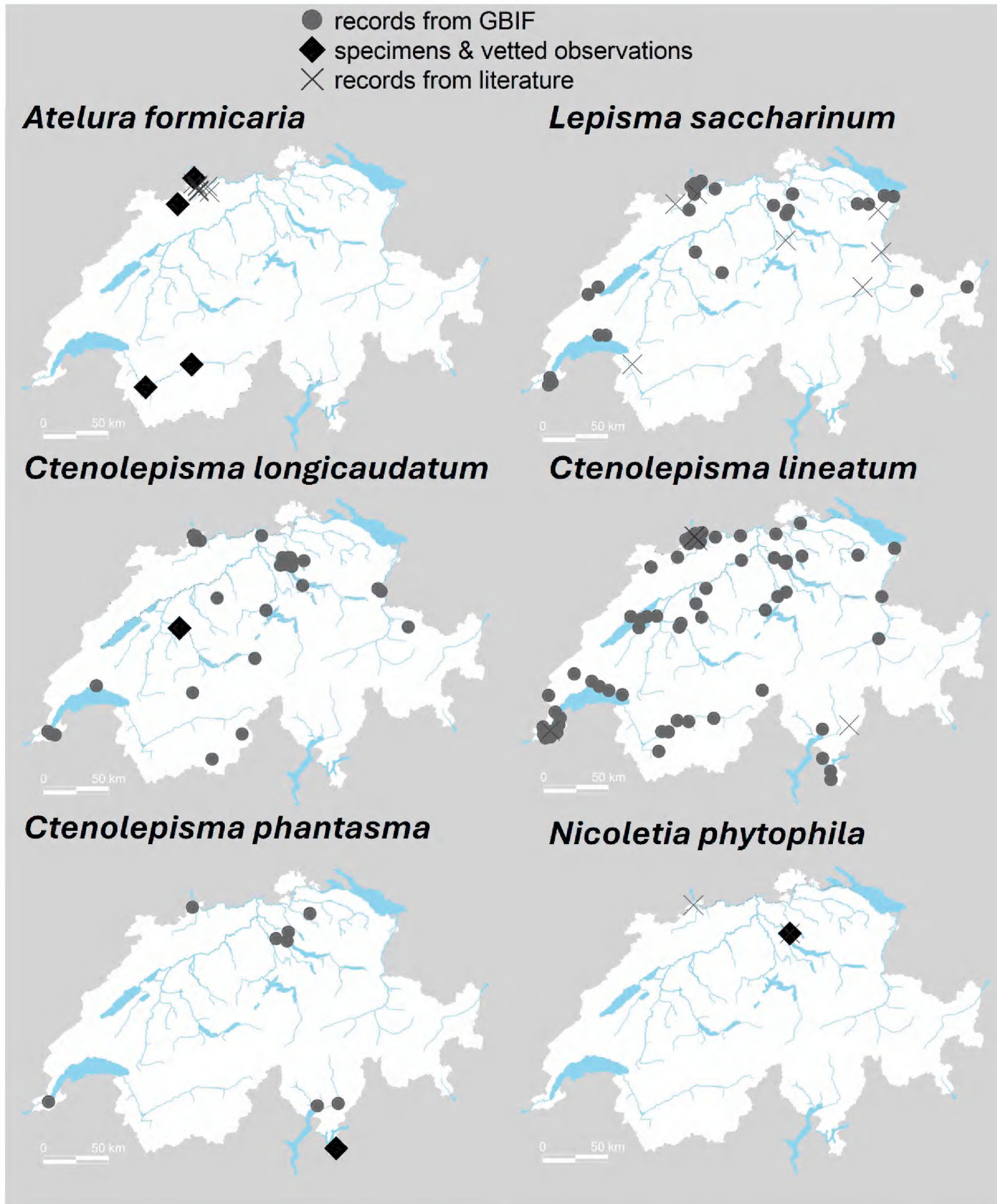

Figure 2. Distribution of Zygentoma in Switzerland based on recent records (see Methods for data range). Background map Swiss Federal Office of Topography.

(Querner et al. 2022). In 2021, the first images of this species were uploaded to iNaturalist (Kulma et al. 2022). All specimens are still identified as *Ctenolepisma calvum*, but according to Raphel et al. (2025) European populations are representatives of their newly described species.

Nicoletia phytophila

Two confirmed locations in Switzerland, from the Botanical Gardens in Zürich and Basel (Gilgado et al. 2021).

Thermobia domestica

In Switzerland, there are indications of its presence dating back to 1999 from the Pest Control Unit of the City of Zurich (with records in 1999, 2002, 3× in 2005, 2× 2007, 2014 and 2015).

Current distribution and recent occurrences of Zygentoma in Switzerland

On GBIF, we found data for *L. saccharinum*, *C. lineatum*, *C. longicaudatum* and *C. calvum* (GBIF.org 2026a, 2026b, 2026c, 2026d) with no Swiss records yet for *C. phantasma*. No data was available in Switzerland for *A. formicaria*, *N. phytophile and T. domestica*. Most observations came from iNaturalist.org (132 from iNaturalist, 20 from observation.org, 2 from naturgucker.de).

Atelura formicaria

Seven records from four locations. Four records from Dreiländereck/Rheinhafen Basel (BS) originate from the first author; all others are from Thomas Stalling. The species is currently only known from the Basel region and Valais. In Fig. 2, the observations of Thomas Stalling are included as "vetted observations".

Specimens. 2 ind., Basel, BS, 28.XII.2021, under stone slab, with *Tetramorium caespitum* complex, Valentin Moser leg., 1 ind. Valentin Moser and Nikolaus Szucsich det., coll. Natural History Museum Vienna

Other records. 2 ind., Basel, BS, 27.XII.2023, under stone slab, with *Tetramorium caespitum* complex, V. Moser det.; ≥32 ind., Basel, BS, 2.XII.2024, under stone slab, with *Tetramorium caespitum* complex, V. Moser det.; 14 ind., Basel, BS, 23.XII.2025, under stone slab, with *Tetramorium caespitum* complex, V. Moser det.; 2 ind., Liesberg, BL, 9.XI.2018, with *Formica* sp., T. Stalling det.; 2 ind., Fully, VS, 18.X.2020, T. Stalling det.; 1 ind., Sierre, VS, 18.X.2020, with *Lasius flavus*, T. Stalling det.

Lepisma saccharinum

32 records from across Switzerland, all from GBIF including three from the authors. The species is widespread north of the Alps, but no observations are yet known from Ticino.

Records from outdoor environments on iNaturalist include. 1 ind., Baulmes, VD, 17.X.2024, on a tree trunk at the entrance to a mine, V. Moser det.; 1 ind., Büsserach, SO, 6.VIII.2023, on a log at a cave entrance, E. Gilgen and V. Moser det.; 1 ind., Chêne-Bougeries, GE, 17.IV.2024, found while digging in a decaying, fallen branch with dry rot, T. Andriollo; 1 ind., Genève, GE, 4.VIII.2023, observed at night in the hollow trunk of a living tree, T. Andriollo; 1 ind., Dietikon, ZH, 29.VI.2025, on paving stones under a bridge, V. Moser det.

Ctenolepisma lineatum

72 records from across Switzerland, all from GBIF, including 4 from the authors. The species appears widespread, with a concentration in warmer regions.

Records from outdoor environments on iNaturalist include. 1 ind., Gampelen, BE, 11.V.2022, in a roofed but otherwise open birdwatching platform, V. Moser det.; 3 ind., Allschwil, BL, 14.II.2020, under wood on a balcony, V. Moser det.; 1 ind., Ardon, VS, 27.VIII.2018, on an artificial substrate outside a house, K. Junker

Ctenolepisma longicaudatum

40 records across Switzerland, all from GBIF, including 5 from the authors. Primarily recorded from the most urban parts of Switzerland, while no outdoor record could be found on iNaturalist. As recent summaries (Molero-Baltanás et al. 2024) do not yet include Swiss records, we consider the specimen collected on 04.08.2023 in Köniz (BE) by the first author and identified by both authors to represent the first vouchered and thus verifiable record for Switzerland:

Specimen. 1 ind., Köniz, BE, 04.VIII.2023, leg. Valentin Moser; det. Valentin Moser and Nikolaus Szucsich; coll. Natural History Museum Vienna

Ctenolepisma phantasma

10 records from all regions of Switzerland outside of the alps, all from GBIF, but as *C. calvum*, including one observation by the authors. So far, the species has been reported only sporadically.

Specimens. 1 ind., Mendrisio, TI, 30.VI.2023, leg. Valentin Moser; det. Valentin Moser and Nikolaus Szucsich; coll. Natural History Museum Vienna

Nicoletia phytophila

It is unclear if the population in Basel survived the renovation of the tropical greenhouse. The first author confirmed the other known population (Gilgado et al. 2021) in Zurich.

Specimens. 2 Ind., Zürich ZH, 07.III.2025, in the Palmenhaus of the Botanical Garden, V. Moser leg., det. & coll.

Thermobia domestica

For this species, there are indications of its presence dating back to 1999 from the Pest Control Unit of the City of Zurich. The species has not yet been recorded on iNaturalist or GBIF within Switzerland. The call to the bakeries and pest control operators had no other positive responses.

Discussion

Some species of Zygentoma are highly adapted to human environments and became cosmopolite species thanks to global transport and trade. In addition to the three native species, at least three non-native species have become established in Switzerland. Despite the close association of many Zygentoma with human structures, they are often overlooked due to their small size and inconspicuous behavior. The actual distribution of Zygentoma in Switzerland is therefore likely much denser than current records suggest. Because many species live near humans, citizen science platforms such as iNaturalist are valuable tools for documenting current distributions or even detecting range expansions (Kulma et al. 2021; Bednár et al. 2023).

Discussion of individual Zygentoma species in Switzerland

Atelura formicaria, the ant silverfish ("Ameisenfischchen" in German) is associated with ants and is the only Zygentoma species in Central Europe typically not found

in buildings. Its distribution spans across Europe (Meineke 2016), with a focus in Central Europe (Robla et al. 2023). In Switzerland, records are rare and usually come from ant nests beneath stones, with no published records since 80 years (Handschin 1929; Wygodzinsky 1941; Meineke 2016). We confirmed the population in Basel and uncovered an additional population in Valais. Its presence in the canton of Valais is outside of the previously known distribution area in Central Europe (Meineke 2016; Robla et al. 2023), but this species also colonizes other inner alpine valleys (Meineke 2016). *Atelura formicaria* seems to be the rarest among the native Zygentoma species with a small distribution and a low number of records. As it is the only species not typically found in buildings, gaps in its distribution could be related to its cryptic myrmecophile lifestyle in ant nests. However, when found, it is rather conspicuous and easily identified based on pictures. The overall distribution range is quite well reflected on iNaturalist, but records from Switzerland are entirely missing on this platform and GBIF. Therefore, it could well be truly rare in Switzerland. In the Basel region, the species could have declined as well: Wygodzinsky (1941) found it regularly at eight locations over two years, whereas today it is only known from a single site near the Dreiländereck in the port area. Even though naturalists have checked under many stones in the region throughout the last years, no further records of this species exist in the area. This species might therefore require a targeted monitoring to ensure its continuous recording in Switzerland. There are also some recent observations close to Switzerland in northern Italy (Robla et al. 2023). *A. formicaria* can be associated with many ant species, including *Lasius niger* (Linnaeus, 1758), *Tetramorium caespitum* (Linnaeus, 1758), *Camponotus ligniperdus* (Latreille, 1802), and *Formica polyctena* (Förster, 1850) (Meineke 2016; Keijl et al. 2023), and is known to able to follow ant pheromone trails (Erhard 1994). Its morphology is highly adapted to life inside ant nests, with a teardrop-shaped body, shortened appendages, and a complete reduction of the eyes.

Lepisma saccharinum, the common silverfish ("Silberfischchen" in German), is now globally distributed due to human activity. It prefers humid environments (around 70% relative humidity) with access to food sources, such as kitchens, toilets and bathrooms (Reichholf 2002; DeVries and Appel 2013). In Europe, it is also found outdoors, for example under stones (Renker et al. 1999; Meineke 2016), and is occasionally associated with ants (Molero-Baltanás et al. 2017; Keijl et al. 2023). In southern Europe, the species is more frequently encountered in natural settings (Molero-Baltanás et al. 2017; Robla et al. 2023). In Switzerland, the first records are from the 18th century (Füssli 1775), and already include both in- and outdoor observations (Wygodzinsky 1941), something we could confirm with our observations. Some picture-based records could actually refer to the genus *Namunukulina*, which was overlooked in Europe until recently (Molero-Baltanás and Fiam 2025). While the streamlined lengthy habitus is shared with the species of *Ctenolepisma*, the common silverfish has shorter abdominal appendages, with cerci seldomly held perpendicular to the body axis. The dorsal scales are all the same color differing among individuals from silvery to brownish and black. With confidence, however, *L. saccharinum* can be separated from the remaining Lepismatidae by smooth, bifid macrochaetae (feathered in the remaining species) and the presence of parameres in male genitalia (Molero-Baltanás et al. 2024).

Ctenolepisma lineatum, the four-lined silverfish ("Streifenfischchen" in German, often also "Kammfischchen", but this is common name of the genus) is native to Europe but has been introduced globally (Molero-Baltanás et al. 2024). The species was described from Switzerland (Fabricius 1775), and its neotype also originates from there (Molero-Baltanás et al. 2012). It is frequently found outdoors in temperate climates, even during winter, suggesting adaptation to colder temperatures (Fink 2016; Meineke 2016; Zimmermann 2016). In Europe, the species is expanding its range and as an example, reached Norway in 2019 (Hage et al. 2020). In Switzerland, this species is capable of surviving outside, as indicated by our own and older records (Wygodzinsky 1941; Zimmermann 2016). The long cerci are mostly held perpendicular to the body axis. This species has dorsal scales in two shades of brown, which form a pattern of longitudinal stripes, hence the German and English vernacular names.

Ctenolepisma longicaudatum, the long-tailed, paper or giant silverfish, was originally described from South Africa (Escherich 1905) but was reported from numerous countries shortly after its description (Lindsay 1940). This suggests that it was already spread by human activities at the start of the 20th century. The species reached Europe in the 20th century, possibly already 1941 in Portugal. The greater part of first records in European countries is from the second half of the 20th century or the start of the 21st century (Kulma et al. 2021; Molero-Baltanás et al. 2024). In Switzerland, this species arrived rather late (Zimmermann 2016; Kulma et al. 2021), but citizen science data from GBIF suggest it is now widespread at least in urban centers. *Ctenolepisma longicaudatum* is still expanding in Europe, primarily in buildings (Aak et al. 2021; Kulma et al. 2021). Its expansion is likely facilitated by modern building infrastructure, including consistent indoor temperatures and the presence of wiring and piping throughout buildings (Aak et al. 2021). It prefers temperatures between 20–26 °C, with slower development between 16–20 °C (Lindsay 1940). The species is more resistant to dryness than, for example, *L. saccharinum*, and is thus well-suited to environments like archives and museums (Aak et al. 2019). The long-tailed silverfish, like indicated by its name, has the longest abdominal appendages of all species known from Switzerland. The dorsal scales are uniformly colored in shades of grey differing between individuals.

In 2025, Raphel et al. redescribed *C. calvum* from Indian populations (Raphel et al. 2025). Due to both morphological and molecular differences all European representatives were assigned to a newly described species *C. phantasma*. European populations of *C. phantasma*

were originally identified as *C. calvum*, and named ghost silverfish ("Geisterfischchen" in German). *Ctenolepisma calvum* was described from Sri Lanka (Ritter 1910), though old records also exist from the Caribbeans (Wygodzinsky 1972). So far, records of *C. phantasma* are limited to Europe and much material needs reexamination (Raphel et al. 2025). It was first reported from Germany in 2007 but likely arrived in Hungary as early as 2003 (Querner et al. 2022). For Switzerland, there is not much data available on GBIF, but regular records from museums during pest monitoring (Querner et al. 2022) suggest that the species might be more common. For the moment, *C. longicaudatum* seems more widespread than *C. phantasma* and has probably been established in Switzerland for longer, consistent with reports from other countries (Kulma et al. 2021, 2022). *Ctenolepisma phantasma* has so far been recorded from only a few sites, but evidence from elsewhere in Europe suggests that it is expanding its range (Querner et al. 2022) and additional Swiss records are therefore expected. Little is known about its ecology. It seems to be able to reproduce parthenogenetically (Watanabe et al. 2023; Molero-Baltanás et al. 2024), which likely facilitates its rapid spread, but in Europe both sexes are reported (Kulma et al. 2022). The dorsal scaling is generally whitish to very pale grey, giving the animal its common name. However, because several *Ctenolepisma* species and juveniles can look similar, identifications should be confirmed microscopically.

Nicoletia phytophila, with no common names, is naturally distributed in tropical regions. In Europe, it has long been known from various greenhouses and was first described from Paris (Gervais 1844). In Switzerland, it has been found in botanical gardens in Basel and Zurich (Gilgado et al. 2021) and at least in Zurich, it persists. It is unclear if it survived the recent rebuilding of the tropical house in Basel. The species lives in soil or litter, and most known populations are female-only (Gilgado et al. 2021). The whitish species is eyeless and lacks scales, so can hardly be mixed with all above species.

Thermobia domestica, the firebrat ("Ofenfischchen" in German), was described from North America. It has been present in Europe for at least a century (Sweetman 1938; Hage et al. 2020). In Switzerland, there are indications of its presence dating back to 1999 from the Pest Control Unit of the City of Zurich, although no specimens exist to date to our knowledge, which would be needed to confirm without doubt the presence of the species in Switzerland. The species is also sold in Switzerland as food for reptiles. The status of the firebrat *T. domestica* remains uncertain, although it is probable that the species has at least occurred in Switzerland. While it is not mentioned in historic reports or collections (Wygodzinsky 1941; Hollier and Cuche 2012), in England in the early 20th century, *T. domestica* was a widespread household pest (Sweetman 1938). Nowadays in the same region on iNaturalist, *T. domestica* records are only a fraction of all Zygentoma records. Its long-term survival is confined to environments with sustained high temperatures, such as bakeries (Sweetman 1938; Tremblay and Gries 2006; Bernal et al. 2022). It is possible that with the disappearance of firewood kitchen stoves and installments of central heating systems, this species lost habitat and has declined significantly. The dorsal scales of the firebrat with different colors form a pattern of transverse bands, which would make it unique among Swiss species.

Overall ecology and outlook

Of the native Zygentoma species in Switzerland, the myrmecophile *A. formicaria* is the most local and specialized species. The other two native species, *L. saccharinum* and *C. lineatum*, appear to be widespread, with *C. lineatum* the most reported Zygentoma species in Switzerland. Both are occasionally found in natural settings (Wygodzinsky 1941), where they seem to prefer warm, sheltered microhabitats such as cave entrances, rock crevices or under bark. They could benefit from climate change and increase their outdoor presence.

Climate change may also facilitate the expansion of Zygentoma species in montane regions. So far, outdoor records are confined to lower elevations (approximately 300–800 m a.s.l.), but at least for the synanthropic species there are higher elevation indoor records. For example, indoor records exist of *L. saccharinum* at 1400 m a.s.l. (Sent, GR) and of *C. longicaudatum* at 1240 m a.s.l. (Ramosch, GR) (iNaturalist observation IDs: 299837429, 264140909, accessed 29.01.2026). These cases illustrate how species can extend their altitudinal niches by exploiting anthropogenic structures. Human activities can alter altitudinal species composition in general (Zhang et al. 2016), but buildings in particular can enable species to occupy elevations otherwise unsuitable (Johnson et al. 2019).

The spread of the newly introduced species may increase competition with native ones. Multiple species can co-occur in a single household (Aak et al. 2019, 20, Kulma et al. 2021), but competitive exclusion cannot be ruled out. Buildings constructed or renovated with seamless, crack-free finishes might lead to habitat loss (Reichholf 2002), but overall, Zygentoma seem to benefit from modern construction practices with the presence of cable and service ducts and warm, stable conditions (Aak et al. 2021). This could help explain the rapid spread and success of *C. longicaudatum* and *C. phantasma*. Data of Pest control companies and integrated pest management in museums and archives could help to better document this species (Querner 2015; Querner et al. 2022). Overall, these changes in the community of Zygentoma in Switzerland and abroad show the dynamic nature of species compositions especially in indoor and urban environments. They highlight how anthropogenic factors, and lifestyles such as building technology and heating techniques combined with global transport of goods can shape synanthropic insect communities.

Monitoring of Zygentoma is useful to detect both native as well as newly introduced species. Climate change could facilitate future natural northward range shifts for species such as *Tricholepisma aureum* (Dufour, 1831). In Austria,

there are records of some populations of *Coletinia maggii* (Grassi, 1887) (Zimmermann 2022), which could also live in climatically suitable areas in Switzerland. In addition, the strong human association of many Zygentoma species facilitates introductions through global trade and travel, with the establishment of populations of species such as *Ctenolepisma rothschildi* (Silvestri, 1907) always possible (Molero-Baltanás et al. 2024; Raphel et al. 2025). For example, in Hungary, there are recent records of *Namunukulina congolense* (Mendes, 1982), a species that can be easily confused with young *L. saccharina* and could be overlooked elsewhere (Molero-Baltanás and Fiam 2025).

To document such range expansions, pictures can be useful to obtain a general overview of species distributions. However, in comparison with other groups such as butterflies, few observations with pictures are available from the public due to low interest and the cryptic nature of Zygentoma. Additionally, identifications based on images should be treated with caution and observers need to be aware of the variability in scale coloration and broken off body appendages (Kulma et al. 2021; Molero-Baltanás et al. 2024). This is especially true for the genus *Ctenolepisma*, where species identifications often require microscopic confirmation to avoid confusion with taxa not yet reported from Switzerland but potentially present (Molero-Baltanás et al. 2024). To monitor such changes, specimens should be collected regularly and vouchered in scientific collections to make identifications confirmable and to document shifts in species composition and distribution.

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